FORM EV-10 - 5-1-44-S

OPERATING INSTRUCTIONS FOR SERIES EV-10-S VACUUM TUBE MULTI-RANGE TESTER

The Series EV-10 is a radically new type of ultra-sensitive measuring instrument specifically developed and engineered to meet the rapidly expanding requirements of the present and future communications, electrical and electronic fields.

Although compact, in terms of physical dimensions, Series EV-10 is a complete AC-DC vacuum tube multi-range circuit tester, providing the full functions of EIGHT distinctly individual instruments, stressing the utmost in performance, ease of manipulation, stability and accuracy (not usually associated with electronic test meters).

A NINTH additional facility is optionally available in the form of the "Series RF-10 Vacuum Tube Probe" which is directly attachable (plug-in cable) at the front of the EV-10 panel. Incorporating a miniature type 9002 tube, this latter accessory provides for direct measurements of super-sonic, R.F. and U.H.F. voltages as required for special laboratory applications.

Before proceeding into the actual use and operation of the Series EV-10's eight basic functions, it will be found desirable to examine the following condensation of the outstanding features and overall coverage of this most unusual instrument:

*VOLTAGE REGULATED--BRIDGE CIRCUIT:- A new departure in stabilized bridge circuit design provides an unusually high degree of direct reading V.T.V.M. accuracy, with practically complete freedom from tube variations. Utilizes one type 6C5, 6X5 and VR-150. Regulated plate voltage power supply remains fully constant over severe line voltage variations, eliminating annoying meter shift due to A.C. line input changes.

*ZERO-CENTER V.T.V.M.- Provides IN ONE OPERATION, BOTH magnitude and polarity of voltage at any test point, WITHOUT reversal of test prods. Common terminal grounded for maximum safety, stability and simplicity of operation.

*SINGLE "MASTER RANGE SELECTOR":- Provides rapid, positive selection of ALL functions and ranges in combination with a simplified 3 position "CIRCUIT SELECTOR".

*SHIELDED COAXIAL TEST PROBES:- Standard AND circuit-isolating coaxial probes furnished as original equipment. Each probe is four feet in length, utilizing high flexibility cable. Circuit-isolating probe permits direct D.C. voltage measurements in signal circuits, without disrupting operating conditions.

*DUO-BALANCED ELECTRONIC-BRIDGE OHMMETER:- A "Precision" development which eliminates gross inaccuracies, sometimes associated with vacuum-tube-ohmmeter readings. BOTH ends of ohmmeter scales are individually zero-adjusted, providing uniformly high accuracy throughout entire scale length. A single "OHMS" scale serves for ALL SIX resistance ranges. V.T.V.M. and OHMMETER zero settings remain essentially unchanged for any series of voltage or resistance range selections.

*FULL VISION 7" RECTANGULAR METER:- Employs extra large, wide faced, easy reading, bakelite cased 7" PRECISION meter. 400 microampere D'Arsonval type movement. Rugged double-bridge construction.

*EACH INSTRUMENT INDIVIDUALLY CALIBRATED with four internal controls sealed against laboratory standards. Assures strict adherence to specified tolerances and duplicate performance of each and every unit.

*59 INDIVIDUAL RANGES ARE DIRECTLY PROVIDED FOR THE MORE THAN ADEQUATE COVERAGE OF NORMAL AND SPECIAL SENSITIVITY MEASUREMENT NEEDS.

*EIGHT ZERO-CENTER VACUUM TUBE VOLTMETER RANGES: - Accuracy 5%
±3, ±6, ±12, ±60, ±300, ±600, ±1200, ±6000 volts D.C.
INPUT RESISTANCE:- 13 1/3 Megohms up to 600 volts, 26 2/3 Megohms at 1200 volts, 133 1/3 Megohms at 6000 volts.

*SIX CIRCUIT-PROBING, ZERO-CENTER, V.T.V.M. RANGES:- Accuracy 5%
±3, ±6, ±12, ±60, ±300, ±600 volts D.C.

Special (resistance-in-probe) shielded coaxial test cable allows measurements to be made in sensitive circuits without affecting receiver or amplifier performance.

*SIX WIDE-RANGE OHMMETER-MEGOHMMETER RANGES:- A 6 volts, internal battery powers all resistance ranges.

0-2000 ohms (20 ohms center scale reading)
0-200M ohms (2000 ohms center scale reading)
0-2 Megohms (20M ohms center scale reading)
0-20 Megohms (200M ohms center scale reading)
0-200 Megohms (2 Mogohms center scale reading)
0-2000 Megohms (20 Megohms center scale reading)

Ideal selection of overlapping ranges for all normal resistance measurement requirements, as well as for insulation resistance tests, condenser tests, etc.

*EIGHT A.C. AND EIGHT D.C. VOLTAGE RANGES at 1000 ohms per volt.
0-3-6-12-60-300-600-1200-6000 volts. 3% D.C. - 5% A.C. accuracy.

A necessary feature for standard (1000 ohms per volt) sensitivity measurements in conformance with the point to point voltage reading tables furnished by receiver manufacturers and in service manuals; equally valuable and desirable for tests not requiring the extreme sensitivity of the V.T.V.M. proper as well as for audio frequency signal measurements.

*SEVEN D.C. CURRENT RANGES:- 3% Accuracy
0-600 Microamperes; 0-3-12-60-300-1200 Milliamperes; 0-12 Amperes.

*EIGHT A.C. OUTPUT RANGES:- Built-in blocking condenser to 600 volts.
0-3-6-12-60-300-600-1200-6000 volts.

*EIGHT DECIBEL RANGES:- from -26 to +70DB. A valuable adjunct for transmission and output level tests and comparisons.

From the foregoing, the reader can readily comprehend the very wide scope of application which Series EV-10 offers and appreciate the complete elimination of frequent annoying shifting from one instrument to another when performing various types of circuit tests. The inherent economy of a device such as Series EV-10 is readily apparent and where this factor is not of major importance, operative efficiency plus single-unit portability of a multiplicity of instruments, becomes a matter worthy of recognition.

THE PANEL COMPONENTS

Examination of the Series EV-10 panel will reveal startingly few components for an instrument which provides eight distinct functions. To the left and right of the bakelite cased (7", 400 microampere) meter, are two groups of pin jacks. Take note that the LEFT hand group is confined solely to functions of the VACUUM TUBE VOLTMETER circuit namely, V.T.V.M. VOLTS and OHMS measurements. Accordingly, ONLY WHEN USING THIS LEFT GROUP OF JACKS IS IT NECESSARY TO HAVE THE INSTRUMENT CONNECTED TO THE A.C. LINE.

The RIGHT hand set of pin jacks has no connection whatsoever with the built-in voltage-regulated power supply or vacuum tube circuits. The RIGHT hand set of jacks provide for AC-DC.VOLTAGE tests at standard (1000 ohms per volt) sensitivity, D.C. CURRENT measurements, OUTPUT and DECIBEL level readings, without any necessity for connecting the instrument line cord to the A.C. line. The Series EV-10 is especially designed so that it can be permanently tied to the A.C. line, in which case the power switch is only turned "ON" when the functional use of Series EV-10 requires it.

Directly beneath the LEFT hand set of pin jacks, will be found a special type of 3 position selector switch labelled "OHMS ZERO CHECK". This switch serves a two-fold purpose:- In positions #1 and #2 it acts purely as the power "OFF" and "ON" switch for those functions of Series EV-10 operating from the A.C. line; In position #3, marked

"O.C." (meaning Ohms Check) the switch automatically performs the job of shorting the ohmmeter test leads for ohms zero-adjusting.

Take note that position #3 incorporates a built-in self-returning spring which automatically brings the lever back to position #2, labelled "ON".

The extreme lower left hand, 3 position selector switch marked "CIRCUIT SELECTOR" provides for simplified choice of the TYPE of measurement the operator chooses to perform with the Series EV-10.

The RANGE (for the particular TYPE of measurement to be made), is chosen on the center 12 position "MASTER RANGE SELECTOR". Notice that each position corresponds to either one of two ranges dependent upon the TYPE of measurement selected. For example, if the "CIRCUIT SELECTOR" is set to "D.C.V.-MA", the OUTSIDE markings of the MASTER RANGE SELECTOR apply -- the outer left hand set of six are in terms of volts and the outer right side in terms of milliamperes, etc.

Directly beneath the right hand set of pin jacks will be found the "OHMS ZERO ADJUST" control which is employed only in conjunction with the ohmmeter circuit, for zero setting the RIGHT HAND (∞) infinity mark end of the "OHMS" scale.

The extreme lower right hand control "V.T.V.M. ZERO ADJUST" is employed for the center zero setting of the V.T.V.M. voltage ranges AND the LEFT HAND (0) zero mark end of the "OHMS" scale.

THE METER SCALE PLATE

It is important to become immediately familiar with the physical layout of the meter scale plate and note that its extreme simplicity allows for maximum ease of reading. (See illustration - Diagram #1.) Just remember that the two uppermost scales are for V.T.V.M. and OHMS functions only, which incidentally are the only facilities requiring that A.C. power be turned "ON".

The remaining three lower scales are labelled for their respective standard multi-range meter purposes and have their OWN set of numerals. They are COMPLETELY INDEPENDENT of the UPPER two scales, just as if this instrument had incorporated two individual meters, one for V.T.V.M.-OHMS purposes and the other for standard multi-range meter functions.

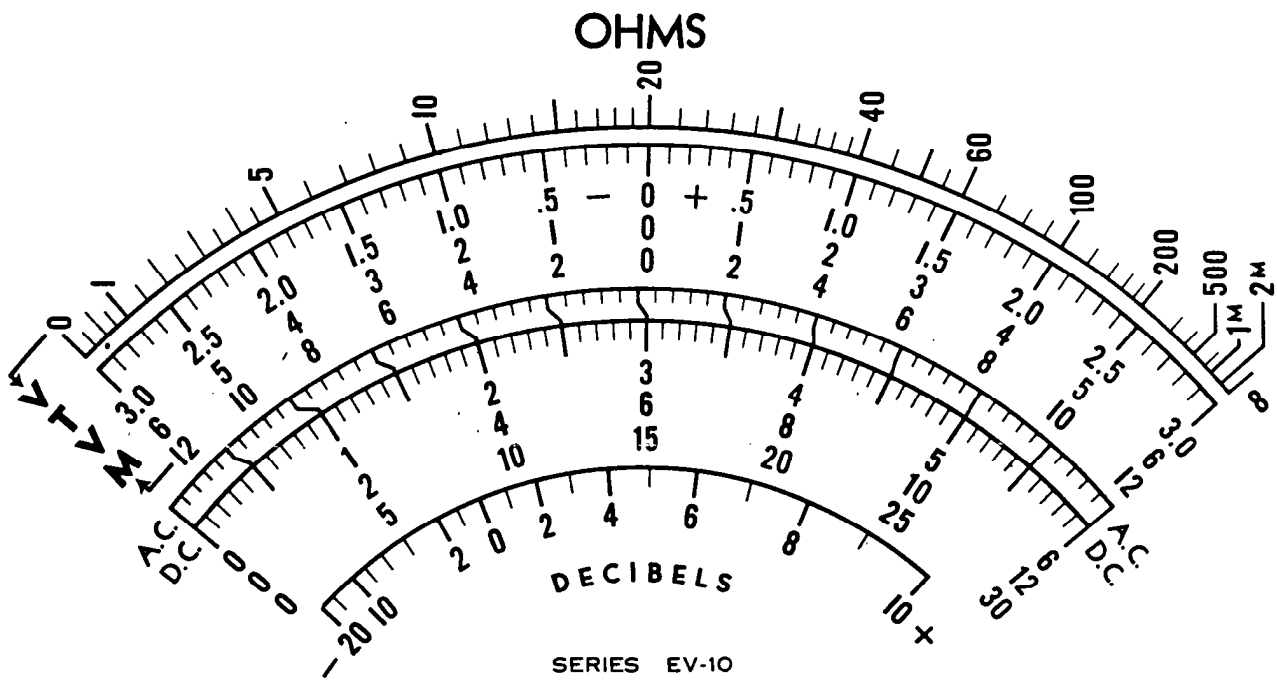
Take note that ONLY THE V.T.V.M. VOLTAGE RANGES ARE ZERO-CENTER. The standard (1000 ohms per volt) scales have their zero at the conventional left hand resting (zero-current) position of the meter. Further note that the extremities of the "V.T.V.M.-OHMS" scales DO NOT coincide with the lower three conventional scales. The "V.T.V.M.-OHMS" scales correspond to the characteristics of the vacuum-tube-bridge which is the heart of the V.T.V.M. voltage and resistance measuring circuits. Therefore, should it ever be necessary to adjust the MECHANICAL zero reset screw (on the meter case itself), it is adjusted with respect to the zero indication of the standard AC-DC scales and NOT the uppermost two scales.

SPECIFIC OPERATING INSTRUCTIONS

To employ either the V.T.V.M. or OHMS functions of this instrument, the fused line plug must be connected to a 110-120 volt 50-60 cycle A.C. source. Other voltage and frequency specifications are accommodated only on special order. Therefore, be certain that this instrument has been designed for YOUR power source specifications. Unless otherwise specified, this instrument should be employed ONLY at the voltage specifications listed above. For your better understanding of the operation of Series EV-10, a complete schematic diagram will be found at the end of this manual.

STANDARD ZERO-CENTER VACUUM TUBE VOLT-METER D.C. RANGES:

Set "CIRCUIT SELECTOR" to "V.T.V.M.-OHMS" position.
Set "MASTER RANGE SELECTOR" to any one of the desired voltage ranges.
Set "OHMS ZERO CHECK" switch to "ON" position with instrument connected to A.C. power line, and allow unit to warm up for a period of about 3 to 5 minutes. The "Standard V.T.V.M.-OHMS Cable" as illustrated in diagram 2-A, should be connected to the "GROUND" and "±" "V.T.V.M.-TESTS" pin jacks BEFORE power is turned on: BLACK tip to "GROUND", RED tip to "±".



VACUUM TUBE MULTI-RANGE TESTER

DIAGRAM #1

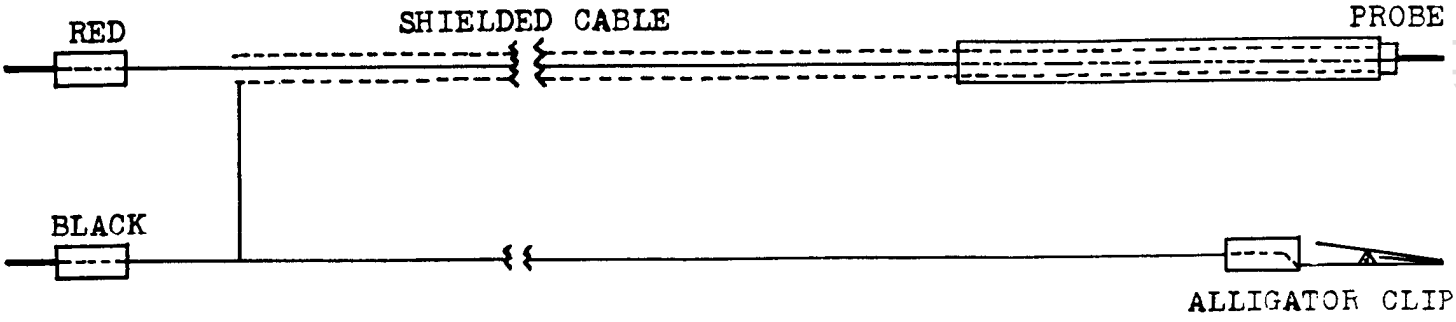


DIAGRAM #2-A STANDARD V.T.V.M. and OHMS CABLE

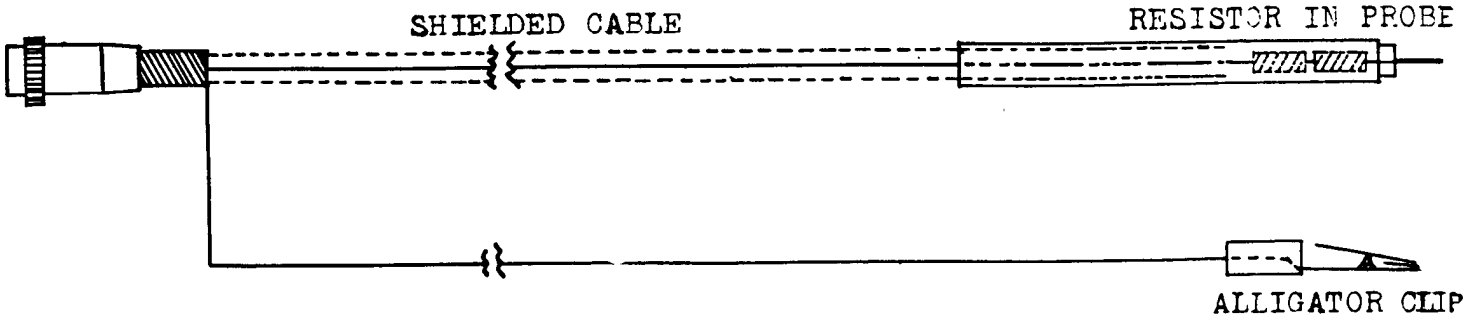


DIAGRAM #2-B CIRCUIT ISOLATING V.T.V.M. CABLE

NOTE:- During the warm-up period, the meter will first deflect slightly to the left and then swing over towards the center-zero position of the V.T.V.M. scale (second from top).

The "V.T.V.M. ZERO ADJUST" control is then rotated toward the "L" (left) or R" (right) hand direction to bring the meter pointer to exact zero center position. Naturally, since this is a vacuum tube device, the probe tip should not be fingered during this operation, otherwise the meter will be deflected and thereby prevent correct zero setting.

It should be remembered that the "+" and "GROUND" pin jacks are employed only for the range of voltages covered by the "MASTER RANGE SELECTOR", namely, up to 600 volts, in steps of 3, 6, 12, 60, 300 and 600 volts full scale. The circuit input resistance, from 3 to 600 volts is 13 1/3 megohms, CONSTANT.

We are now ready for D.C. voltage tests in any type of circuits, except where the "Circuit Isolating Probe" would be more desirable to prevent disrupting tuned and other signal sections, such as the grids of R.F., I.F. and audio amplifiers, etc.

Always set the "MASTER RANGE SELECTOR" to the highest range first when voltage of unknown value is to be measured, and then change setting to appropriate lower range as dictated by the initial reading.

The ALLIGATOR TERMINAL CLIP is connected to the GROUND TERMINAL or CHASSIS of the device under test and the PROBE directly to the point at which voltage measurement is to be made. The meter will instantly indicate BOTH the magnitude and polarity of the voltage with respect to neutral ground. As marked on the meter scale plate, readings to the LEFT of center zero are NEGATIVE (-) and to the RIGHT, POSITIVE (+).

READ METER AS FOLLOWS on second scale from top:-

3 volt range, read directly on 3.0 scale.
6 volt range, read directly on 6 scale.
12 volt range, read directly on 12 scale.
60 volt range, read directly on 6 scale and multiply by 10.
300 volt range, read directly on 3.0 scale and multiply by 100.
600 volt range, read directly on 6 scale and multiply by 100.

For the 1200 volt range, the "BLACK" (shield) tip plug of the standard testing probe is inserted into the "GROUND" "V.T.V.M. TESTS" pin jack and the "RED" tip plug into the RED "1200V" pin jack. "MASTER RANGE SELECTOR" MUST BE SET TO THE 600V POSITION WHENEVER EMPLOYING THE 1200V RANGE. 1200 volt range reads on 12 scale multiplied by 100.

For the 6000 volt range, NEVER EMPLOY the standard V.T.V.M. shielded test probe. Use only Precision #228 extra high voltage, super-flex test leads or equivalent. "BLACK" lead tip plug inserts into "GROUND" tip jack and RED lead tip plug into RED "6000V" tip jack. "MASTER RANGE SELECTOR" MUST BE SET TO 600V POSITION WHENEVER EMPLOYING THE 6000V RANGE. 6000 volt range reads on 6 scale, multiplied by 1000.

The circuit input resistance on 1200 volt range is 26 2/3 megohms and on 6000 volt range, is 133 1/3 megohms.

From all of the foregoing, the operator can immediately comprehend the tremendous value of a voltage measuring device with such high input sensitivity, especially realizing that even at 3 volts, the input resistance is 13 1/3 megohms.

When employing the V.T.V.M. D.C. voltage measuring functions of Series EV-10, it is desirable to occasionally recheck on the center-zero reset adjustment inasmuch as some slight variation may be caused by changes in temperature within the instrument case. Line voltage fluctuations are automatically compensated by the built-in VR-150 regulated power supply.

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CIRCUIT PROBING ZERO-CENTER D.C. V.T.V.M. RANGES:-

In addition to the foregoing eight regular D.C. V.T.V.M. ranges, there are provided 6 D.C. voltage ranges through use of a circuit isolating probe which permits voltage tests to be made directly at tube elements and other "hot" circuit positions, without materially affecting operating conditions.

As illustrated in diagram 2-B, the "CIRCUIT-ISOLATING V.T.V.M. CABLE" incorporates a resistor directly at the probing tip, so that basically the very small capacity of the tiny metal tip is the only disturbing influence on a unit under analysis.

The "CIRCUIT-ISOLATING V.T.V.M. CABLE" will connect in only one way to the polarized "PROBE" connector. The test ends are employed in the same manner as outlined for the use of the standard V.T.V.M. cable, and ranges selected in a duplicate fashion. It should be noted that circuit probing ranges are limited to 600 volts as selected directly at the "MASTER RANGE SELECTOR".

NOTE:- The #2 contact of the circuit probe connector is not "dead" at the Series EV-10 panel, but supplies 6.3 volts A.C. to power the filament of the Series RF-10 ultra-high frequency A.C. probing tube.

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OHMMETER MEGOHMMETER RANGES:-

Series EV-10 provides for an unusually wide range of DIRECT resistance measurements in six overlapping ranges. All ohmmeter ranges are selected directly on the six inner right-hand positions of the "MASTER RANGE SELECTOR" and are read on the uppermost scale as follows:

0-2000 ohms range (20 ohms at center scale) read directly.
0-200,000 ohms range (2,000 ohms center) read on 2000 scale and multiply by 100.
0-2 Megohms range (20,000 ohms center) read on 2000 scale and multiply by 1000.
0-20 Megohms range (200,000 ohms center) read on 2000 scale and multiply by 10,000.
0-200 Megohms range (2 Megohms center) read on 2000 scale and multiply by 100,000.
0-2000 Megohms range (20 Megohms center) read on 2000 scale and multiply by 1,000,000.

To employ the ohmmeter functions of Series EV-10, the "STANDARD V.T.V.M. AND OHMS CABLE" is connected as follows:

BLACK (shield) tip plug to "SHIELD" pin jack.
RED (probe) tip plug to "HIGH" pin jack.

With "CIRCUIT SELECTOR" set to "V.T.V.M.-OHMS" position and "MASTER RANGE SELECTOR" to desired ohmmeter range, turn instrument "ON" and allow 3 to 5 minutes for warm up, if instrument has not been already previously used and hence in heated condition.

The meter pointer will (if heating, first deflect slightly to left, then) swing toward the infinity mark (∞) end of the "OHMS" scale, which, as previously mentioned, DOES NOT coincide with the end of the "AC-DC" (1000 ohms per volt) scales.

Zero adjustment on a vacuum tube operated ohmmeter differs a bit from the more conventional types and requires separate adjustment or setting of each end of the scale -- one with test leads OPEN and the other with test leads SHORTED.

With Series EV-10, the clumsiness and inconvenience of shorting test leads has been fully eliminated through incorporation of a special switching position on the "Ohms Zero Check" switch, from which purpose the switch has derived its name. The "O.C." (Ohms Check) position serves this "Test Lead Shorting" purpose. Note that this "O.C." position has a built-in spring return which automatically "unshorts" the test leads, when released, and brings the switch back to the "ON" position. Naturally, the A.C. power remains "ON" even with the "Ohms Zero Check" switch in the "O.C." position.

We are now ready to make our zero adjustments, which in reality are very simple, once performed a few times:- With "Ohms Zero Check" switch held in "O.C." (test leads effectively shorted) position, meter pointer will swing to left (possibly off scale). Rotate "V.T.V.M. ZERO ADJUST" control until pointer coincides with zero line of "OHMS" scale. Release the "Ohms Zero Check" switch; needle will swing to right (possibly off scale) and rotate "Ohms Zero Adjust" control until pointer coincides with the infinity mark (∞) or extreme right end of "OHMS" scale. Inasmuch as there is some inter-reaction between the settings of these controls, the above process should then be repeated until BOTH ends of the "OHMS" scale are properly adjusted. Once set, these adjustments will hold for the last five ohmmeter ranges without change. The first (2000 ohms) range may require slightly different settings because of the variation of internal battery resistance, which effects a low ohms range such as this.

Similar experience has no doubt been had with any multi-range ohmmeter, wherein the very low reading scale required a different setting of the zero-adjust control even though the higher ranges fell right in with each other when once adjusted. The reason for this is the same as just previously mentioned.

Ohmmeter zero-adjustment of Series EV-10 will be found even simpler, if the approximate final positions of the controls are noted for future reference. Of course, the settings will slowly change, as the batteries grow older, and in this connection, Series EV-10 has been designed, (as have all Precision testers) to accommodate widest possible variation in battery potential without affecting ohmmeter accuracy. In addition, the dual zero adjusting system provided in Series EV-10 offers unusually high direct reading "OHMS" scale accuracy, not generally associated with electronic apparatus.

CAUTION:- Always first disengage AT LEAST ONE END of resistance from the circuit before making resistance measurements, or else an indication of the true resistance value may not be obtained due to the possibility of the circuit therein involved effectively shunting the resistance to be measured, thus reducing the true reading by an amount proportionate to the resistance of the included shunt network. Also be sure that ABSOLUTELY NO VOLTAGE IS PRESENT at the resistance under test. In this connection, the surest method is to completely disconnect the device under surveyance, from any and all sources of power, including grounds.

The "STANDARD V.T.V.M. and OHMS CABLE" leads are applied across the two points whereat resistance measurements are to be taken; the alligator clip to the "low" side of the resistor, (if one end is still connected to some circuit), and the probe tip to the other.

NOTE:- All ohmmeter ranges, in addition to their relation to the bridge vacuum tube circuit, make use of a 6 volt battery, consisting of four 1½ volt cells in series. They are designated as Eveready #935 or equivalent. Batteries should be replaced, in the same manner as will be found originally installed, when full scale deflection can no longer be obtained at BOTH ends of the "OHMS" scale, or in other words, when the "OHMS ZERO ADJUST" and "V.T.V.M. ZERO ADJUST" can no longer perform required zero setting. Of course, if the 6C5, VR-150 or 6X5 go bad, they too will affect the operation of the V.T.V.M. and OHMS networks, in which case they should be replaced with equivalent types.

IMPORTANT: - If the VR-150 voltage regulator is removed from its socket, the instrument cannot be turned "ON". There is a power line interlock completed through a jumper in the base of this tube. NEVER attempt to operate the V.T.V.M. or OHMS circuits with VR-150 removed and interlock arbitrarily jumped. If instrument does not work at all, always check BOTH 1 AMP fuses in fused plug at end of A.C. line cord.

BATTERY CONNECTIONS are:- RED lead to (+) plus 6 volts and BLACK lead to minus (-) 6 volts. The BLACK lead should be left permanently soldered to the brass pressure spring unless chassis must be removed from cabinet. To take out chassis, remove the 12 border screws ONLY. The RED lead is soldered directly to the brass terminal of the fourth 1½ volt battery comprising the series chain.

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STANDARD 1000 OHMS PER VOLT MULTI-RANGE METER FUNCTIONS

Unlike the "V.T.V.M.-OHMS" functions of Series EV-10, this set of facilities DOES NOT require connection to any power source AND IS NOT ZERO-CENTER, but rather conventional left hand zero. Particular note should be made of the fact that the RIGHT hand set of pin jacks, under the label "AC-DC VOLTS-MA", is employed for these regular tests. The operation is as simple as when employing a fully individual standard sensitivity instrument. The regular, UNSHIELDED, flexible (Red and Black rubber) test leads are used for these functions.

The lower right hand set of polarized pin jacks, marked "EXTERNAL TESTS" are used for all A.C. and D.C. voltage, current and decibel measurements except for "12 AMPERES", "1200 VOLTS", "6000 VOLTS" and "OUTPUT", for which latter extended ranges, special jacks are provided. The minus (-) "EXTERNAL TESTS" tip jack is COMMON to all f the right hand set except for the "12 AMPERES" range, which carries its own positive (+) and negative (-) jacks.

A.C. VOLTAGE MEASUREMENTS:- 1000 ohms per volt

The high sensitivity of this circuit suitably adapts it to both power and audio frequency measurements, limited by the fact that copper-oxide rectifier response decreases rapidly as frequency increases materially above 7000 to 8000 cycles. For normal routine applications, the input impedance may be considered to be 1000 ohms multiplied by the voltage range being employed, or 300,000 ohms at 300 volts, etc.

Set "CIRCUIT SELECTOR" switch to the "A.C.V.-DB" position for all A.C. voltage measurements. Select suitable voltage range on the "MASTER RANGE SELECTOR". Read A.C. voltage on RED. A.C. CORRECTION SCALE (third scale from top) as follows:

0-3 volts read on 30 scale, divide by 10
0-6 volts read directly on 6 scale
0-12 volts read directly on 12 scale
0-60 volts read on 6 scale, multiply by 10
0-300 volts read on 30 scale, multiply by 10
0-600 volts read on 6 scale, multiply by 100
0-1200 volts read on 12 scale, multiply by 100
0-6000 volts read on 6 scale, multiply by 1000

IMPORTANT NOTE: - When employing the "1200" and "6000" volts pin jacks, (for which the (-) "EXTERNAL TESTS" jack is the COMMON), the "MASTER RANGE SELECTOR" should ALWAYS be set to the 600V position.

NOTE:- When using the A.C. (1000 ohms per volt) scales, a slight vibration of the meter pointer tip may be noticeable. This should be no cause for alarm. It is merely attributable to the fact that Series EV-10 meter employs an unusually long pointer in order to provide wide-spread easy reading scales; this extended pointer length therefore greatly magnifies the very minute pulsations which A.C. rectifiers transmit to the meter movement. It will be found, however, that this vibration is not discernable at the portion of its length which intersects the A.C. correction scale, and therefore in no way whatsoever affects accuracy or readability.

D.C. VOLTAGE MEASUREMENTS:- 1000 OHMS PER VOLT

The standard "1000 ohms per volt" sensitivity ranges will be found highly invaluable for routine voltage tests in conformance with point to point voltage reading tables furnished in service manuals and in radio receiver manufacturers' service notes. When higher sensitivity is required, Series EV-10 can be automatically switched to V.T.V.M. functions and ONE INSTRUMENT thereby serves all of your requirements. The circuit switching is so arranged that there is ABSOLUTELY NO INTERCONNECTION between V.T.V.M. and STANDARD functions, so that actually the instrument can, at all times, be left connected to the power line and even turned "ON". In this manner, the operator can switch back and forth between the various test facilities, and thereby avoid delay in preheating, whenever V.T.VM. or OHMS tests are desired.

For all STANDARD D.C. voltage measurements, set "CIRCUIT SELECTOR" to the "D.C.V.-MA" position and select suitable voltage range on "MASTER RANGE SELECTOR". Read D.C. voltage on "D.C." scale (fourth scale from top) as follows:

0-3 volts read on 30 scale, divide by 10
0-6 volts read directly on 6 scale
0-12 volts read directly on 12 scale
0-60 volts read on 6 scale, multiply by 10
0-300 volts read on 30 scale, multiply by 10
0-600 volts read on 6 scale, multiply by 100
0-1200 volts read on 12 scale, multiply by 100
0-6000 volts read on 6 scale, multiply by 1000

IMPORTANT NOTE:- When employing the " 1200" and " 6000" volts pin jacks, (for which the (-) "EXTERNAL TESTS" jack is the COMMON), the "MASTER RANGE SELECTOR" should ALWAYS be set to the 600V. position.

ALL VOLTAGE MEASUREMENTS ARE MADE WITH THE TEST LEADS APPLIED ACROSS LOAD. OBSERVE PROPER POLARITY AT TIP JACKS. THE D.C. CIRCUIT OF ALL STANDARD SENSITIVITY FUNCTIONS IS NOT ZERO CENTER.

IMPORTANT GENERAL PRECAUTIONS
When testing High Voltage Circuits

This applies equally to V.T.V.M. as well as 1000 ohms per volt tests.

Whenever making voltage measurements in ANY circuits wherein the potentials exceed 3000 volts, it is advisable for the operator to connect the instrument panel to a good GROUND. The cold water pipe is usually sufficient. Connection should be made from ground source to under one of the instrument panel border mounting screws.

This practice will protect the operator at all times from electrostatic charges which may readily accumulate on instrument panel, or in the case of metal cased units, on both case and panel.

BEFORE making ANY MEASUREMENTS in a Television Receiver or in ANY OTHER DEVICE wherein the POSITIVE (+) side of the high voltage power supply is connected to chassis, it is absolutely IMPERATIVE that all EXTERNAL ground connections be removed. This includes the following:

1. DISCONNECT ANY external grounding leads (such as from radiators, cold water pipes or power line neutrals) which may be connected (directly or through a condenser) to the receiver or device upon which measurements are to be made.
2. COMPLETELY DISCONNECT ALL power line by-pass condensers from their connections to the A.C. line cord or power transformer primaries of the device under test.

NEVER attempt adjustment or test of any circuits (such as television receivers) wherein exceedingly dangerously high voltages are present unless a complete circuit diagram is available to identify the location of all high potential terminals. Always employ well insulated test leads, such as the Precision Extra High Voltage Super-Flex Test Leads, Part #228. Available from distributor.

Make sure hands and shoes are DRY when performing tests wherein high voltages are involved.

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D.C. CURRENT MEASUREMENTS

It is important to note that the "12 AMPERES" range is ONLY obtainable through the use of its respective set of tip jacks located at upper right corner of the instrument panel, WHEN "MASTER RANGE SELECTOR" IS SET TO THE 1200 MA POSITION.

Set "CIRCUIT SELECTOR" switch to the "D.C.V.-MA" position for all D.C. current measurements. Select proper current range on the "MASTER RANGE SELECTOR". Read D.C. current measurements on "D.C." meter scale as follows:

0-.6MA read on 6 scale, divide by 10
0-3MA read on 30 scale, divide by 10
0-12MA read directly on 12 scale
0-60MA read on 6 scale, multiply by 10
0-300MA read on 30 scale, multiply by 10
0-1200MA read on 12 scale, multiply by 100
0-12 AMPS read directly on12 scale

NOTE:- When using the "12 AMPERE" D.C. range, never remove pin jacks while current is flowing through the circuit. Failure to observe this would result in arcing at the pin jack being removed, and though it would not injure the meter, the jack would gradually char.

ALL CURRENT MEASUREMENTS ARE MADE WITH TEST LEADS IN SERIES WITH LOAD. OBSERVE PROPER POLARITY AT TIP JACKS.

CAUTION:- When voltage or current of unknown value is to be measured, it is advisable to employ the highest range first. If meter indication is slight, then select next lower range, etc. Adhere closely to the above in order to prevent slamming of meter pointer and meter overloading.

OUTPUT METER INDICATIONS

The A.C. voltage measurements at a high sensitivity of 1000 ohms per volt makes the instrument ideally suitable for use as an output meter.

There are two methods that can be used for obtaining output meter indications as listed below:

IN THE FIRST METHOD, make connections from the voice coil of speaker or secondary of output transformer to "EXTERNAL TESTS" tip jacks. In the event that easy access to the voice coil or secondary of transformer cannot be had, then refer to method outlined below.

IN THE SECOND METHOD, make connections from plate of output tube and ground or chassis of radio receiver to "OUTPUT" and (-) "EXTERNAL TEST" tip jacks. A .1 mfd. 600 w.v. condenser is already included in series with the "OUTPUT" lead in order to block the D.C. component. The voltage appearing at the points across which the output measurements are taken should never be in excess of 600 volts peak, otherwise an additional condenser of equal capacity and of equal or higher rating should be included externally in series with the "OUTPUT" jack.

PROCEDURE: With the use of either method noted above, set "CIRCUIT SELECTOR" switch to the "A.C.V.-D.B." position and rotate "MASTER RANGE SELECTOR" to highest voltage range. An output meter indication will be had when signal generator and radio receiver is put into operation. If the meter indication is slight, then use the next lower A.C. voltage range, etc.

Any gain or loss by reason of balancing or trimming will be accordingly noted by corresponding meter pointer deflection.

NOTE:- The output meter can also be used to great advantage for obtaining comparisons in tube performance by noting the difference in meter indications when any or all of the tubes are substitued in the radio receiver under test. Also note that 600 volts is the highest range on which the "OUTPUT" jack can be employed. For higher output voltage tests the regular 1200 and 6000 volt jacks are employed with an appropriately rated series condenser.

DECIBEL METER

The Series EV-10 incorporates a direct reading and calibrated decibel scale enabling readings from -26 to +70DB in eight ranges.

The initial scale reading -20 to +10DB is based upon a zero level of 6 milliwatts or 1.73 volts across a 500 ohm load, 500 ohms being that most generally employed in audio work. The most common use of a decibel meter is that of a power level indicator across known impedances. Because of calibration at one definite impedance, conversions must be made to the new impedance when used at other than 500 ohms. Such tables may be found in a multiplicity of text-books and technical magazines.

NOTE:- Refer to Decibel Conversion Table, last page of this booklet, for interpretation of decibel readings in terms of power, power ratios, voltage and voltage ratios.

Caution must be observed in the use of the DB ranges that the circuit across which the meter is placed is isolated from all D.C., else the meter and/or rectifier unit may be damaged or at least erroneous readings obtained, depending upon whether the D.C. voltage is greater or less than the voltage scale to which the decibel scale corresponds, and the duration of the misapplication.

PROCEDURE: Make connections from across 500 ohm load to "EXTERNAL TESTS" tip jacks. Set "CIRCUIT SELECTOR" switch to the "A.C.V.-D.B." position for all DECIBEL READINGS. Select suitable DB range on "RANGE SELECTOR" and read as follows on DB scale:

-6 DB range, read directly on initial DB scale (-20 to +10 DB), subtract 6 DB
0 DB range, read directly on initial DB scale (-20 to +10 DB)
6 DB range, read directly on initial DB scale and add +6 DB
20 DB range, read directly on initial DB scale and add +20 DB
34 DB range, read directly on initial DB scale and add +34 DB
40 DB range, read directly on initial DB scale and add +40 DB
46 DB range, read directly on initial DB scale and add +46 DB
60 DB range, read directly on initial DB scale and add +60 DB

(Use "1200V." tip jack for 46 DB. range and "6000V." tip jack for 60 DB. range, with "MASTER RANGE SELECTOR" at 600 volt (+40 DB) position.)

CURRENT MEASUREMENTS OF LEAKAGE IN ELECTROLYTIC CONDENSERS.

The leakage in an electrolytic is measured in terms of D.C. current (per microfarad) flowing through the condenser, when rated D.C. voltage is applied.

All electrolytic condensers contain an inherent current leakage. However, if leakage above an allowable amount is present, it can then be termed as poor. Allowable current leakage is dependent upon such factors as age and manufacturers' specifications of a condenser, design of power unit, filter system and rectifier tube of the radio receiver in which the condenser is incorporated. In general, considering an 8 mfd. condenser THAT HAS BEEN IN USE (rated at 450 volts), the maximum allowable leakage is approximately .5 MA per microfarad or 4 MA total.

The following will serve as a basis for computing approximate allowable leakages:

(a) For condensers rated at 300 volts or more, leakage of approximately .5 MA per microfarad is permissible.

(b) For condensers rated between 100 to 275 volts, permissible leakage is approximately .2 MA per microfarad.

(c) For condensers rated below 100 volts, permissible leakage is approximately .1 MA per microfarad.

CAUTION:- WHEN OBTAINING ELECTROLYTIC LEAKAGE MEASUREMENTS, HIGH VOLTAGE IS EMPLOYED. IT IS THEREFORE EXTREMELY IMPORTANT THAT THE FOLLOWING INSTRUCTIONS BE ADHERED TO IMPLICITLY TO PREVENT DAMAGE TO METER.

PROCEDURE: With condenser disconnected from radio receiver circuit, CHECK CONDENSER FOR SHORT with ohmmeter using the 0-200,000 OHMS RANGE. POLARITIES MUST BE OBSERVED. The "SHIELD" tip jack is connected to outside can or negative terminal of condenser and the "HIGH" tip jack is connected to the anode (positive) terminal of condenser. A decided low resistance reading or constant full scale deflection of ohmmeter pointer indicates that the condenser is shorted and SHOULD BE REJECTED WITHOUT FURTHER TESTING.

When an electrolytic INCORPORATED IN A RADIO RECEIVER is to be tested, the necessary rated voltage is automatically applied and the following connections are made for "forming" and measuring the current leakage, after being (ohmmeter) tested for short.

1. Set "CIRCUIT SELECTOR" switch to the "D.C.V.-MA" position and rotate "MASTER RANGE SELECTOR" to the 300 MA position.

2. Remove lead from (positive) anode terminal of condenser and connect this lead to the positive (+) "EXTERNAL TESTS" tip jack with a PROPER LIMITING RESISTOR IN SERIES. (Where voltage applied to condenser is above 100 volts, the limiting resistor should be approximately 2000 ohms. When the applied voltage is below 100 volts, the value of the limiting resistor should be approximately 500 ohms. This limiting resistor is very important and should not be omitted.)

3. Connect the negative (-) "EXTERNAL TESTS" pin jack to the (positive) anode terminal of condenser. (From the above connections, it can be seen that the "EXTERNAL TESTS" tip jacks, limiting resistor, condenser terminals and voltage source are in series connection.)

4. After series connections are made, turn on switch of radio set. The meter pointer will now deflect to near full scale and then gradually recede to the zero mark or near zero, after the expiration of about three minutes. THIS PROCEDURE IS KNOWN AS "FORMING" THE CONDENSER.

NOTE:-A steady meter pointer indication without receding to or near zero (after forming process) indicates a shorted or leaky electrolytic and should be rejected WITHOUT FURTHER TESTING.

5. After "forming", short out the limiting resistor and read current leakage of condenser under test directly on the 300 MA scale. If meter reading is under 60 MA, set "RANGE SELECTOR" to the 60 MA position for a better meter indication and read on 60 MA scale, etc. (For computation of permissible condenser leakage, refer to basis noted previously.)

CAUTION:-After this test is completed, always first disconnect the negative test lead from circuit before turning off power supply to prevent slamming of meter pointer due to discharge of condenser under test.

To test electrolytic condensers NOT INCORPORATED IN A RADIO SET, an external D.C. power supply is necessary, preferably one that employs various voltage taps suitable to application for the various D.C. voltage condenser ratings. In this case, adhere to the same testing procedure as noted above in paragraphs 1, 4 and 5, but making the following series connections:

(a) Select voltage tap of D.C. power supply approximating rated voltage of condenser to be tested.

(b) Connect positive potential of power supply to the positive (+) "EXTERNAL TESTS" tip jack with a 2000 ohm limiting resistor in series if applied potential is above 100 volts. If potential is 100 volts or under, use a 500 ohm limiting resistor.

(c) Connect negative potential of power supply to outside can or negative terminal of condenser.

(d) Connect negative (-) "EXTERNAL TESTS" tip jack to the (positive) anode terminal of condenser.

(e) Refer to paragraphs 1, 4 and 5, for obtaining current leakage measurements.

* * * * * *

QUALITATIVE PAPER CONDENSER TESTS:- Using V.T.V.M. voltage ranges, OHMS RANGES, or 1000 Ohms Per Volt Scales.

The insulation resistance or permissible leakage of paper and mica condensers is expressed in megohm microfarads. A good 1 mfd. condenser will have an insulation of approximately 450 megohms. Furthermore, insulation resistance of paper and mica condensers of similar voltage ratings is inversely proportional to its capacity, so that a good .1 mfd. condenser will have ten times the insulation resistance of a similar 1 mfd. condenser, or 4500 megohms. It therefore can be readily seen that it would not be entirely accurate to use even the Series EV-10 high range ohmmeter for measuring leakages in paper or mica condensers when the capacity is smaller than .1 mfd.

In the method to be described, a high D.C. potential is applied to the condenser in series with the proper D.C. VOLTS range (V.T.V.M. or 1000 ohms per volt -- the former much more sensitive because of its very high input resistance) to determine ether or not it has low insulation resistance or abnormal leakage.

The necessary D.C. potential can be obtained from an external high voltage D.C. power supply or from the power output tube socket of a radio receiver. In the

latter instance, the plate prong position of that socket will be the positive high voltage lead, and the negative return or ground will be the negative lead. Voltage to be applied to the condenser should be greater than its rated voltage.

PROCEDURE:

1. Measure and adjust the D.C. voltage obtainable from D.C. power supply. Then select the proper meter range that would indicate full scale deflection for the voltage there available and in keeping with the condenser rating.

2. With the power supply OFF, insert the condenser to be tested in series with one of the test leads.

3. Turn ON power supply. An instantaneous deflection due to the charge of the condenser will be indicated on the D.C. meter.

(a) In the case of a good condenser, the needle pointer will recede to (or VERY close to) the zero voltage mark.
(b) If the meter pointer remains noticeably above the zero mark, then this indicates that the condenser has abnormal leakage.
(c) If the meter pointer remains at the indicated value of the voltage measurement obtained primarily, then the condenser is "shorted".
(d) If no meter deflection is obtained, then this indicates that the condenser is "open" or that the capacity is too low in value to indicate an instantaneous noticeable meter deflection when charged.

NOTE:- After this test is completed, always FIRST disengage the negative test lead from circuit BEFORE turning off power supply to prevent slamming of needle pointer due to discharge of condenser under test.

Fundamentally speaking, the 2000 meg range of Series EV-10 (with 20 megohm center scale reading) is more sensitive than even the 600 volt V.T.V.M. range, whereat the effective center scale reading (when employed as above) is the input resistance of the V.T.V.M. or 13 1/3 Megohms. However, all of the D.C. voltage ranges of the V.T.V.M. have the same 13 1/3 Megohm sensitivity and thereby allow tests to be made right at the actual working voltage of the particular condenser under test, whereas the "OHMS" circuit checks at ONLY 6 volts. (This 6 volts rating is definitely advantageous for OHMS purposes though not always sufficient for decisive dynamic condenser testing.) Therefore, when condenser testing through use of high voltage, leakages or breakdowns can be detected which might not reveal themselves with normal low voltage ohmmeter checks.

* * * * * *

GENERAL INFORMATION

In an instrument manual of this nature, it is generally inadvisable to attempt to cover too much ground, other than the basic operation of the facilities available. In practice, there is no limit to the number of applications to which an instrument such as Series EV-10 may be applied, bounded only by the operator's technical training and necessities.

Accordingly, it is strongly suggested that reference be made to one or more of many excellent texts and articles on the application and use of vacuum-tube-voltmeters, vacuum-tube-ohmmeters, standard multi-range meters, etc. Such articles provide detailed data and calculations (when necessary) for such useful measurement simplifications as "Guard" terminals for insulation leakage tests; application of D.C.-V.T.V.M.'s to peak and R.M.S., R.F. measurements, microammeter measurements, etc.

A brief recommended reference list is furnished herewith, from which selection can be made commensurate to the operator's own advancement:

PERIODICALS: -

Proceedings of the I.R.E. -- Institute of Radio Engineers.
Electronics -- McGraw Hill Publishing Company.
Communications -- Bryan Davis Publishing Company.
R.C.A. Review -- R.C.A. Institutes Technical Press.
General Radio Experimenter -- General Radio Company

* Aerovox Research Worker -- Aerovox Manufacturing Company.
* Service -- Bryan Davis Publishing Company.
* Radio & Television Today -- Caldwell-Clements Publishing Company.
* QST -- American Radio Relay League.
and others

TEXTS:

* Ghirardi-Radio Physics Course -- Radio Technical Publishing Company.
* Rider-Vacuum Tube Voltmeters -- John F. Rider Publisher, Inc.
Eastman-Fundamental's of Vacuum Tubes -- McGraw Hill Book Company.
Chaffee-Theory of Thermionic Vacuum Tubes-McGraw Hill Book Company.
Hund-High Frequency Measurements -- McGraw Hill Book Company.
Reich- Theory and Application of Electron Tubes -- McGraw Hill Book Co.
Brown- R.F. Electrical Measurements -- McGraw Hill Book Company.
and others

* Denotes (fundamental) in nature

NOTE:- A slight overload will damage or change characteristics of the meter rectifier. Rectifiers are checked before instruments leave the factory. It is important to note this fact inasmuch as rectifiers are not guaranteed when overloaded.

Instructions and guarantee card are enclosed with this instrument. Mail the guarantee card at once for future information to be mailed from this record. Always give Pattern Number and Serial Number when writing for information relative to this instrument.

SERIES EV-10 ACCESSORIES INCLUDED:

4 – #950 - 1½ volt Eveready Batteries
1 – Set #227 Standard Super-Flex Test Leads for use with RIGHT HAND set of pin jacks, but NOT SAFE for 6000 volt ranges
#228 extra high voltage test leads are recommended for 6000 volts
1 – Standard V.T.V.M. and OHMS CABLE
1 – Circuit-Isolating V.T.V.M. CABLE
1 – Kit of tubes consisting of 6C5-GT, 6X5-GT and VR-150
1 – Series EV-10 Instruction Manual

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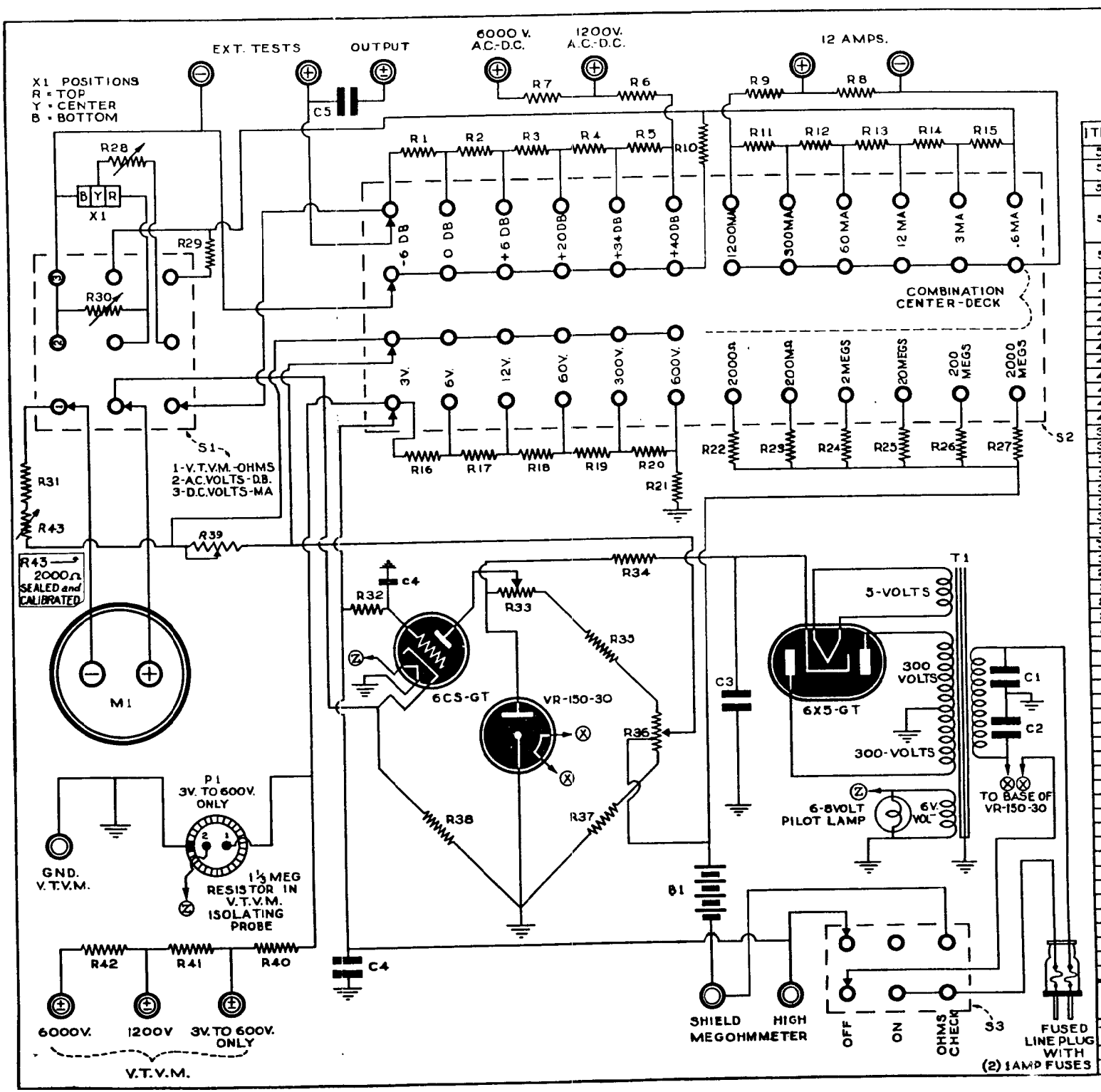
PRECISION APPARATUS CO., INC.
92-27 Horace Harding Blvd.
Elmhurst, L.I.,N.Y.

DECIBEL CONVERSION CHART

Power Level DB	Power Ratio to 0 DB	Power .006 Watt at 0 DB Watts	Voltage Ratio to 0 DB	Volts – Based on .006 Watt at 0 DB in	
				500 ohms	600 ohms
−10	0.1000	0.0006000	0.31623	0.5477	.6000
— 9	0.1259	0.0007553	0.35481	0.6145	.6732
— 8	0.1585	0.0009509	0.39811	0.6895	.7554
— 7	0.1995	0.0011972	0.44668	0.7737	.8475
— 6	0.2512	0.0015071	0.50119	0.8681	.9509
— 5	0.3162	0.0018975	0.56234	0.9740	1.0670
— 4	0.3981	0.0023886	0.63096	1.0928	1.1972
— 3	0.5012	0.0030071	0.70795	1.2262	1.3433
— 2	0.6310	0.0037857	0.79433	1.3758	1.5071
— 1	0.7943	0.0047660	0.89125	1.5437	1.6910
0	1.0000	0.0060000	1.00000	1.7321	1.8974
+ 1	1.2589	0.0075535	1.1220	1.9434	2.1289
+ 2	1.5849	0.0095093	1.2589	2.1805	2.3886
+ 3	1.9953	0.0119716	1.4125	2.4466	2.6801
+ 4	2.5119	0.0150713	1.5849	2.7451	3.0071
+ 5	3.1623	0.0189747	1.7783	3.0801	3.3741
+ 6	3.9811	0.0238865	1.9953	3.4559	3.7867
+ 7	5.0119	0.030071	2.2387	3.8776	4.2477
+ 8	6.3096	0.037857	2.5119	4.3507	4.7660
+ 9	7.9433	0.047660	2.8184	4.8816	5.3475
10	10.0000	0.060000	3.1623	5.4772	6.0000
11	12.589	0.075535	3.5481	6.1455	6.7321
12	15.849	0.095093	3.9811	6.8954	7.5536
13	19.953	0.119716	4.4668	7.7368	8.4752
14	25.119	0.150713	5.0119	8.6808	9.5094
15	31.623	0.189747	5.6234	9.7400	10.670
16	39.811	0.238865	6.3096	10.9285	11.972
17	50.119	0.30071	7.0795	12.2620	13.433
18	63.096	0.37857	7.9433	13.7582	15.071
19	79.433	0.47660	8.9125	15.4369	16.910
20	100.000	0.60000	10.0000	17.3205	18.974
21	125.89	0.75535	11.220	19.434	21.289
22	158.49	0.95093	12.589	21.805	23.886
23	199.53	1.19716	14.125	24.466	26.801
24	251.19	1.50713	15.849	27.451	30.071
25	316.23	1.89747	17.783	30.801	33.741
26	398.11	2.38865	19.953	34.559	37.867
27	501.19	3.0071	22.387	38.776	42.477
28	630.96	3.7857	25.119	43.507	47.660
29	794.33	4.7660	28.184	48.816	53.475
30	1000.00	6.0000	31.623	54.772	60.000
31	1258.9	7.5535	35.481	61.455	67.321
32	1584.9	9.5093	39.811	68.954	75.536
33	1995.3	11.9716	44.668	77.368	84.752
34	2511.9	15.0713	50.119	86.808	95.094
35	3162.3	18.9747	56.234	97.400	106.70
36	3981.1	23.8865	63.096	109.285	119.72
37	5011.9	30.071	70.795	122.620	134.33
38	6309.6	37.857	79.433	137.582	150.71
39	7943.3	47.660	89.125	154.369	169.10
40	10000.0	60.000	100.000	173.205	189.74
41	12589.2	75.535	112.20	194.34	212.89
42	15848.9	95.093	125.89	218.05	238.86
43	19952.6	119.716	141.25	244.66	268.01
44	25118.9	150.713	158.49	274.51	300.71
45	31622.8	189.747	177.83	308.01	337.41
46	39810.7	238.865	199.53	345.59	378.67
47	50118.7	300.71	223.87	387.76	424.77
48	63095.7	378.57	251.19	435.07	476.60
49	79432.7	476.60	281.84	488.16	534.75
50	100000.0	600.00	316.25	547.72	600.00

DWG Nº 1037d



ITEM	PART NO.	SPECIFICATION
55	S1	3 POSITION CIRCUIT SELECTOR
54	S2	12 POSITION RANGE SELECTOR 2 DECK'S BELOW SERIAL Nº 4580 - 4 DECKS ABOVE.
53	S3	3 POSITION LINE & OHMS CHECK
52	P1	ISOLATING PROBE CONNECTOR — ALSO PROVIDES FILAMENT VOLTAGE FOR RF-10 RADIO FREQ. PROBING UNIT
51	B1	6 VOLT BATTERY - (4) 1.5 V. CELLS EVEREADY Nº 950 OR EQUIVALENT
50	M1	400 μ AMPS - 160 M.V.
49	T1	POWER TRANSFORMER
48	X1	METER RECTIFIER
47	C5	.1 MFD - 600 W.V.
46	C4	.002 MFD - 400 W.V.
45	C3	16 MFD - 450 W.V.
44	C2	.01 MFD - 400 W.V.
43	C1	.01 MFD - 400 W.V.
42	R42	106⅔ MEGOHMS
41	R41	13⅓ MEGOHMS
40	R40	1⅓ MEGOHMS
39	R39	4100 Ω - OHMS ZERO ADJUST
38	R38	6000 Ω
37	R37	330 Ω
36	R36	225 Ω - V.T.V.M. ZERO ADJUST
35	R35	11,950 Ω
34	R34	4715 Ω - 10 WATTS
33	R33	3000 Ω - SEALED CALIBRATED
32	R32	500 MΩ
31	R31	8500 Ω
30	R30	12 MΩ - SEALED CALIBRATED
29	R29	2840 Ω
28	R28	3000 Ω - SEALED CALIBRATED
27	R27	20 MEGOHMS
26	R26	2 MEGOHMS
25	R25	200 MΩ
24	R24	20 MΩ
23	R23	2000 Ω
22	R22	20 Ω
21	R21	60 MΩ
20	R20	60 MΩ
19	R19	480 MΩ
18	R18	2.4 MEGOHMS
17	R17	3.0 MEGOHMS
16	R16	6.0 MEGOHMS
15	R15	640 Ω
14	R14	120 Ω
13	R13	32 Ω
12	R12	6.4 Ω
11	R11	1.2 Ω
10	R10	267 Ω CALIBRATED
9	R9	.36 Ω
8	R8	.04 Ω
7	R7	4.8 MEGOHMS
6	R6	600 MΩ
5	R5	300 MΩ
4	R4	240 MΩ
3	R3	48 MΩ
2	R2	6000 Ω
1	R1	3000 Ω

PRECISION APPARATUS COMPANY

TITLE-SERIES EV-10-S

DRAWN BY Mark Gotham DATE 5-15-44

CHECKED BY MG. DATE 5-19-44